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CONTRIBUTION OF THE CIRCUMTERRESTRIAL DUST CLOUD TO THE BRIGHTNESS OF THE ZODIACAL LIGHT AND F- CORONA

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SUMMARY

Various models of the zodiacal dust are discussed. It is shown that the circumterrestrial dust cloud contributes essentially to the brightness of zodiacal light and provides for no less than one tenth of the observed brightness.

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The results of measurements of dust particle flows, conducted with the aid of rocket and satellites, have shown that there exists in the vicinity of the Earth a relatively dense dust cloud. According to analysis by Whipple [1] the dependence of the particle flow N on the distance h from the Earth's surface is determined by a function of the form $N(h) \sim h^{-1.4}$. Soberman and Della Lucca [2] obtained a dependence $N(h) \sim h^{-1.1}$ (Fig. 1), and Nazarova [3] found $N(h) \sim h^{-1}$. These dependences are found by measurements with the aid of acoustic detectors, sensitive to particles with mass $> 10^{-9}$ g, which corresponds to particles with radius of the order of 10 mk. Assuming even the slowest variation, that is, $N(h) \sim h^{-1}$, the mean value of the flow in the region of the sphere of Earth's attraction ($h < 2.6 \cdot 10^5$ km) exceeds by two orders the value of the flow at the boundary of Earth's action ($h = 9.3 \cdot 10^5$ km). Therefore, we may estimate that the mean particle concentration of the

* O VKLADE OKOLOZEMNOGO PYLEVOGO OBLAKA V YARKOST' ZODIAKAL'NOGO SVETA I F-KORONY.

circumterrestrial dust cloud with radii > 10 mk exceeds the concentration of the heliocentrical dust cloud at the distance of 1 a.u. from the Sun by no less than two orders, if we assume at the same time, that at distances $> 10^6$ km from ground, the concentration of particles remains constant and does not decrease as in the vicinity of the Earth.

An estimate of the contribution that might be made by particles of the circumterrestrial dust cloud to zodiacal light and F-corona is of interest. With this in view, we computed for the ecliptic the brightnesses conditioned by the heliocentrical dust cloud and those due to the circumterrestrial dust cloud. It was then admitted that the latter spreads to distances of $2.6 \cdot 10^5$ km from Earth, that is, to the boundary of Earth's attraction, while the dust concentration of the former at the distance of one astronomical unit from the Sun corresponds to the concentration obtained from rocket measurements at the distance of the order of 10^6 km, that is at the limit of Earth's sphere of action.

If $d\Delta$ is the element of distance Δ between the observer and the scattering element along the visual ray (Fig. 2), a is the radius of particles, $n(a, r)$ is the concentration of particles at the distance r from the Sun, $\psi(\theta, a)$ is thescattering indicatrix, I_0 is the solar radiation flux at the distance $R = 1.5 \cdot 10^8$ km from the Sun, the flux of light DB, scattered per unit of solid angle at the scattering angle θ will be

$$dB = I_0\left(\frac{R}{r}\right)^2 \pi a^2 \psi(\theta, a) n(a\ r)\, da\, d\Delta. \qquad (1)$$

The brightness B, conditioned by the heliocentrical cloud, is determined by the double integral

$$B = I_0 \pi \int_{a_1}^{a_2} \int_0^{\infty} \frac{a^2 R^2}{r^2} \psi(\theta, a) n(a, r)\, da\, d\Delta. \qquad (2)$$

Taking into account that

$$\frac{R}{r} = \frac{\sin\theta}{\sin\varepsilon} \quad \textit{and} \quad d\Delta = R\frac{\sin\varepsilon}{\sin^2\theta}\, d\theta$$

and assuming that

$$n(a, r) = C\left(\frac{R}{r}\right)^{\alpha} \frac{da}{a^p},$$

where C, α and p are constants, we shall obtain

$$B(\varepsilon) = \pi I_0 RC \operatorname{cosec}^{1+\alpha} \varepsilon \int_{a_1}^{a_2} \int_{\varepsilon}^{\pi} \frac{\psi(\theta, a) \sin^{\alpha} \theta}{a^{p-2}} \, da d\theta. \qquad (3)$$

We have admitted that the scattering indicatrix consists of two addends $\psi(\theta, a) = \psi_d(\theta, a) + \psi_2(\theta)$, the first of which being determined by diffraction, and the second by the reflection, in the assumption, that

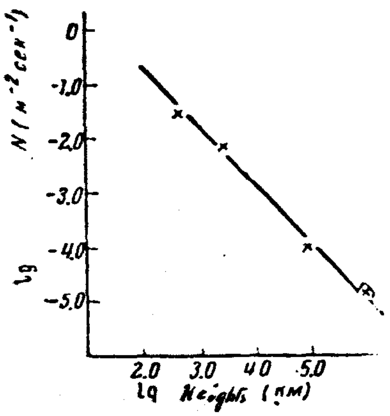
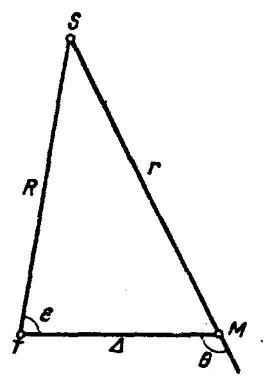


Fig. 1. - Dependence of the flow N (m^{-2} sec^{-1}) of dust particles on the distance h (km) from the Earth's surface [2].



F ig. 2. - Scheme of Sun's (S), Earth's (T) and of considered element's (M) positions

particles are sphere-like and that the intensity of the reflected light is subject to Lambert law, that is

$$\psi_r(\theta) = \frac{2A}{3\pi^2} (\sin\theta - \theta\cos\theta), \qquad (4)$$

where A is the albedo of scattering particles. For the diffraction part of the indicatrix we may admit the function

$$\psi_d(\theta, a) = \frac{1}{\pi} \frac{J_1^2(x\sin\theta)}{\sin^2\theta}, \qquad (5)$$

where $J_1(z)$ is a Bessel function of 1st order, $x = 2\pi a/\lambda$, λ is the wavelength of incident radiation assumed to be equal to 0.58 mk. Then

$$B(\varepsilon) = I_0 RC \operatorname{cosec}^{1+\alpha} \varepsilon \int_{a_1}^{a_2} \int_{\varepsilon}^{\pi} \frac{\sin^{\alpha}\theta}{a^{p-2}} \left[\frac{J_1^2(x\sin\theta)}{\sin^2\theta} + \frac{2A}{3\pi} (\sin\theta - \theta\cos\theta) \right] \times da d\theta. \qquad (6)$$

Breaking down the brightness of scattered radiation into two components — the diffraction $B_d(\varepsilon)$ and the reflection $B_r(\varepsilon)$, we shall obtain $B(\varepsilon) = B_d(\varepsilon) + B_r(\varepsilon)$,

where

$$B_r(\varepsilon) = \frac{2}{3\pi} A I_0 R C \operatorname{cosec}^{1+\alpha} \varepsilon \int_{a_1}^{a_2} \int_{\varepsilon}^{\pi} \frac{\sin^{\alpha}\theta}{a^{p-2}} (\sin\theta - \theta\cos\theta)\, da\, d\theta, \qquad (7)$$

$$B_d(\varepsilon) = I_0 R C \left(\frac{2\pi}{\lambda}\right)^{p-3} \operatorname{cosec}^{1+\alpha} \varepsilon \int_{\varepsilon}^{\pi/2} \sin^{\alpha+p-5}\theta\, d\theta \int_{x_1 \sin\theta}^{x_2 \sin\theta} \frac{J_1^2(z)}{z^{p-2}} dz. \qquad (8)$$

A new integration variable $z = x \sin\theta$ is introduced in the last integral. Formulas (7) and (8) are derived for the heliocentrical cloud. If we admit for the sake of simplifications of calculations, that the concentration of particles in the circumterrestrial dust cloud does not depend on distance, that is, if we assume $n(a) = C' da / a^p$, where C' is the mean value of the coefficient C for $\Delta \leq 2.6 \cdot 10^5$ km, the corresponding brightnesses $B'_r(\varepsilon)$ and $B'_d(\varepsilon)$, conditioned by the circumterrestrial dust cloud, will be determined by the formulas:

$$B_r'(\varepsilon) = \frac{2}{3\pi} A I_0 R C' \operatorname{cosec} \varepsilon \int_{a_1}^{a_2} \int_{\varepsilon}^{\theta(\varepsilon)} \frac{\sin\theta}{a^{p-2}} (\sin\theta - \theta\cos\theta)\, da\, d\theta \qquad (9)$$

$$B_d'(\varepsilon) = I_0 R C' \left(\frac{2\pi}{\lambda}\right)^{p-3} \operatorname{cosec} \varepsilon \int_{\varepsilon}^{\theta(\varepsilon)} \sin^{p-5}\theta\, d\theta \int_{x_1 \sin\theta}^{x_2 \sin\theta} \frac{J_1^2(z)}{z^{p-2}} dz, \qquad (10)$$

that can be derived directly or obtained from (7) and (8), if we assume $\alpha = 0$, change the upper integration limit over θ and introduce C' in place of C. At the same time the upper limit of $\theta(\varepsilon)$ is determined from the correlation

$$\operatorname{ctg}\theta = \operatorname{cosec}\theta \left(\operatorname{cosec} - \frac{2.6 \cdot 10^5}{1.5 \cdot 10^8} \right). \qquad (11)$$

The values of the Bessel function $J_1(z)$ were borrowed from the tables of [4], where this function is tabulated for $z \leq 25$. For $z > 25$ we used the asymptotic formula

$$J_1(z) = \sqrt{\frac{2}{\pi z}} \sin\left(z - \frac{\pi}{4}\right), \qquad (12)$$

which, for the case $p = 4$, gives

$$\int_{z_1}^{z_2} \frac{J_1^2(z)}{z^2} dz = \frac{1}{\pi} F_2(z) - \frac{1}{\pi} \left(\frac{1 - \sin 2 z_2}{2 z_2^2} - \pi \right), \qquad (13)$$

where

$$F_2(z_1)=\frac{1-\sin 2z_1}{2z_1^2}-\frac{\cos 2z_1}{z_1}-2\mathrm{si}\,2z_1,$$

at the same time, for $2z_2 > 100$ we utlized the aymptotic formula

$$2z_2=\frac{\pi}{2}-\frac{\cos 2z_2}{2z_2}.$$

For the case $p=3$

$$\int_{z_1}^{z_2}\frac{J_1^2(z)}{z}\,dz=\frac{1}{\pi}\left[F_1(z_1)-\frac{1}{z_2}\right] \tag{14}$$

where

$$F_1(z_1)=\frac{1}{z_1}-\frac{\sin 2z_1}{z_1}+2\mathrm{ci}\,2z_1.$$

Here, for $2z_2 > 100$, the asymptotic formula $\mathrm{ci}\,2z_2=\frac{\sin 2z_2}{2z_2}$ was utilized. Assuming

$$H_r(\varepsilon)=\frac{2}{3\pi}I_0R\operatorname{cosec}^{1+\alpha}\varepsilon\int_{a_1}^{a_2}\frac{da}{a^{p-2}}\int_{\varepsilon}^{\pi}\sin^{\alpha}\theta(\sin\theta-\theta\cos\theta)\,d\theta,$$

$$H_d(\varepsilon)=I_0R\left(\frac{2\pi}{\lambda}\right)^{p-3}\operatorname{cosec}^{1+\alpha}\varepsilon\int_{\varepsilon}^{\pi/2}\sin^{\alpha+p-5}\theta\,d\theta\int_{x_1\sin\theta}^{x_2\sin\theta}\frac{J_1^2(z)}{z^{p-2}}\,dz,$$

$$H_r'(\varepsilon)=\frac{2}{3\pi}I_0R\operatorname{cosec}\varepsilon\int_{a_1}^{a_2}\frac{da}{a^{p-2}}\int_{\varepsilon}^{\theta(\varepsilon)}\sin\theta(\sin\theta-\theta\cos\theta)\,d\theta.$$

$$H_d'(\varepsilon)=I_0R\left(\frac{2\pi}{\lambda}\right)^{p-3}\operatorname{cosec}\varepsilon\int_{\varepsilon}^{\theta(\varepsilon)}\sin^{p-5}\theta\,d\theta\int_{x_1\sin\theta}^{x_2\sin\theta}\frac{J_1^2(z)}{z^{p-2}}\,dz,$$

we shall have

$$\begin{aligned}B_r(\varepsilon)&=CAH_r(\varepsilon),\\ B_d(\varepsilon)&=CH_d(\varepsilon),\\ B_r'(\varepsilon)&=C'AH_r'(\varepsilon),\\ B_d'(\varepsilon)&=C'H_d'(\varepsilon).\end{aligned} \tag{16}$$

If we admit $I_0=6.8\cdot10^{-5}$, the brightnesses obtained by (15) and (16) will be expressed in units of solar disk's average brightness. The functions $H_r(\varepsilon)$, $H_d(\varepsilon)$, $H_r'(\varepsilon)$ and $H_d'(\varepsilon)$ are computed by us for the values $p=3$ and $p=4$ and for $a_1=1$ and $a_1=10$ mk. The value of the upper limit of a_2 was taken equal to 1 cm. When computing $H_r(\varepsilon)$ and $H_d(\varepsilon)$, it was taken into account, that no particles of dust exist at all inside a sphere of radius equal to 0.1 a.u. around the Sun (empty zone). At computing $H_d(\varepsilon)$ a correction was made for the finite dimensions of the Sun using a method expounded in [5] and applied in [6], by way of introduction of a multiplier $\rho(\varepsilon)$, the values of which varying approximately from 2 to 1 at change of elongations from 20' to 2°. Naturally, these corrections have a meaning only for the inner F-corona and already at $\varepsilon > 2^\circ$ $\rho(\varepsilon) = 1$.

The graphs of the functions $H_r(\varepsilon), H_d(\varepsilon), H_r'(\varepsilon)$ and $H_d'(\varepsilon)$ for different values of a_1 are plotted in the logarithmic scale in Figs 3 and 4. For comparison the course of brightness variation of the F-corona and of zodiacal light as a function of elongation is also shown in relative units.

The total brightness of the zodiacal light will be determined by the formula

$$B = B_r + B_d + B_r' + B_d' = CAH_r + CH_d + C'AH_r' + C'H_d' = CS_i + C'T_i,$$

where

$$S_i = AH_r + H_d, \qquad T_i = AH_r' + H_d'.$$

Being only interested by the order of the investigated quantities, we assumed $A = 0.1$. If we postulate that $C = kC'$, we shall have

$$B = C'(kS_i + T_i),$$

where C' is the mean value of the coefficient C for the circumterrestrial dust cloud. In correspondence with the above-said, k does not exceed the value $k = 10^{-2}$.

The constant C' can be determined by formula (18), provided we use the values of the function $T_i + kS_i$, computed for various models of the dust cloud and for the observed brightnesses of the F-corona and of zodiacal light. If, at the same time, it is found, that the obtained values of C' vary significantly within the considered elongation interval, such a model can not be accepted, for the obtained brightness course for it, as a function of elongation, will not correspond to that observed. Besides, when selecting the dust cloud model, we may compare the absolute values of C' found by (18) with its value obtained as a result of rocket measurements.

Evidently, this second criterion is less reliable than the first one, based upon the comparison of the computed relative course with the observed.

According to the data of [2] we may admit, that for particles with radii $a > 10$ mk, the mean value of the flux $N(a)$ for the circumterrestrial dust cloud is $10^{-3}\,m^{-2}\,sec^{-1}$. If we take for particle velocity $v = 20$ km/s, the corresponding value of concentration will be

$$n(a) = 2N(a)/v = 10^{-13}\ cm^{-3},$$

that is

$$n(a) = \int_{10^{-3}}^{\infty} \frac{C'da}{a^p} = 10^{-13}.$$

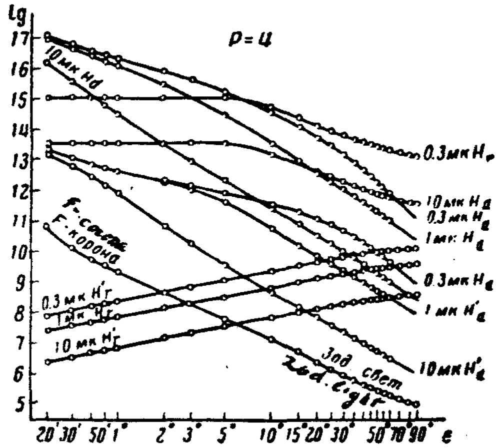


Fig. 3. - Functions H_d, H_r, H_d' and H_r' for models with $p = 4$.

This gives for C' the following values as a function of the admitted value of p:

$$C' = 2 \cdot 10^{-19} \quad \text{for} \quad p = 3,$$
$$C' = 3 \cdot 10^{-22} \quad \text{for} \quad p = 4.$$

The values of the coefficient C', obtained in (18) for various models of the dust cloud at $p = 4$ are compiled in Table 1, and those for models $p = 3$, — in Table 2. The models considered differ by radii a_1 of the tiniest particles present in the cloud. The letter T refers to the circumterrestrial cloud, and S — to the heliocentrical one. Therefore, $T_{0.3} + S_{10}$, for example, serves as denotation of a model in which the circumterrestrial cloud has particles of radius $a > 0.3$ mk, and the heliocentric cloud — particles with radius $a > 10$ mk. For illustration, we brought out in the last three columns the values of the coefficient C, obtained without taking into account the circumterrestrial cloud. In the second column of the Tables, F-corona brightnesses were borrowed from [6] and those of zodiacal light — from [7]; both are expressed in units of solar disk's average brightness. In the upper part of the Table, we brought up the multipliers pointing to number order of each column.

TABLE 1

$p = 4$

№ model / № модели		1	2	3	4	5	6	7	8	9	10	11	12
	brightness	$T_{0.3}$	T_1	T_{10}	$T_{0.3}+S_{0.3}$	T_1+S_1	$T_{10}+S_{10}$	$T_{0.3}+S_1$	$T_{0.3}+S_{10}$	T_1+S_{10}	$S_{0.3}$	S_1	S_{10}
ε	яркости	C'	C'	C'	C'	C'	C'	C'	C'	C'	C	C	C
		10^{-23}	10^{-22}	10^{-21}	10^{-24}	10^{-23}	10^{-22}	10^{-23}	10^{-23}	10^{-22}	10^{-26}	10^{-25}	10^{-24}
20′	$6.0 \cdot 10^{-8}$	280	29	4.2	54	6.2	3.7	6.2	35	3.6	55	6.4	4.
30′	$1.2 \cdot 10^{-8}$	110	11.	2.1	22	2.8	2.8	2.8	25	2.5	22	2.8	3.1
40′	$5.8 \cdot 10^{-9}$	81	8.4	2.2	17	2.3	3.6	2.3	28	2.8	17	2.3	4.2
50′	$3.4 \cdot 10^{-9}$	60	6.4	2.3	13	2.0	4.5	2.0	29	3.0	13	2.0	5.3
1°	$2.3 \cdot 10^{-9}$	51	5.4	2.9	11	1.9	5.8	1.8	30	3.1	11	1.9	7.6
2°	$4.4 \cdot 10^{-10}$	20	2.4	8.2	5.2	1.4	10	1.4	17	2.0	5.3	1.5	12.3
3°	$1.7 \cdot 10^{-10}$	12	1.6	9.7	3.7	1.4	12	1.4	11	1.4	3.9	1.5	13
5°	$6.3 \cdot 10^{-11}$	8.0	1.4	18	3.2	1.7	10	1.6	7.5	1.2	3.4	1.9	11
10°	$1.5 \cdot 10^{-11}$	4.5	2.0	27	3.4	2.7	7.5	1.8	7.7	1.6	3.7	3.1	7.
15°	$4.9 \cdot 10^{-12}$	2.7	3.8	29	3.0	2.8	5.7	1.4	2.6	2.3	3.3	3.1	5.8
30°	$8.4 \cdot 10^{-13}$	1.9	3.5	21	3.4	2.5	3.9	1.1	1.8	1.9	4.1	2.7	4 .8
35°	$6.0 \cdot 10^{-13}$	2.0	3.6	17	3.7	2.5	4.0	1.1	1.9	1.8	4.6	2.7	3.0
40°	$4.3 \cdot 10^{-13}$	2.1	3.7	13	3.9	2.4	3.3	1.1	1.9	1.8	4.3	2.6	3.7
45°	$3.4 \cdot 10^{-13}$	2.4	3.8	10	4.4	2.4	3.2	1.2	2.3	1.7	5.4	2.5	3.4
50°	$2.7 \cdot 10^{-13}$	2.6	3.4	8.0	4.6	2.3	2.1	1.3	2.4	1.6	5.6	2.5	3.4
55°	$2.2 \cdot 10^{-13}$	3.0	2.9	6.3	5.0	2.2	2.8	1.3	2.7	1.4	5.9	2.4	2.1
60°	$1.8 \cdot 10^{-13}$	2.9	2 6	5.0	4.9	2.1	2.5	1.3	2.6	1.3	5.9	2.3	2.9 .7

TABLE 2

$p = 3$

№ модели	1	2	3	4	5	6	7	8	9	10
model №	T0.3	T_1	T_{10}	T_1+S_1	$T_{10}+S_{10}$	T0.3+S_1	T0.3+S_{10}	T_1+S_{10}	S_1	S_{10}
ε	C'	C'	C'	C'	C'	C'	C'	C'	C	C
	10^{-19}	10^{-19}	10^{-19}	10^{-20}	10^{-20}	10^{-20}	10^{-20}	10^{-20}	10^{-22}	10^{-23}
20′	15	14	16	9.3	17	9.4	17	17	10	19
30′	8.8	8.2	10	5.8	14	5.8	14	14	6.2	17
40′	8.6	8.3	12	6.6	20	5.9	18	18	6.4	23
50′	8.0	7.7	14	5.9	24	5.9	22	25	6.4	30
1°	8.0	7.7	18	6.2	31	6.2	26	28	6.7	38
2°	6.1	6.1	37	6.2	45	6.2	28	24	6.9	51
3°	5.4	5.7	47	6.3	39	6.2	24	16	7.1	42
5°	5.5	6.9	84	10	21	9.6	15	11	12	21
10°	5.3	11	150	6.5	12	3.0	10	8.6	6.9	12
15°	4.2	17	140	5.4	8.9	4.9	7.4	6.2	5.6	9.0
30°	3.7	14	50	3.9	5.9	3.6	5.1	5.7	4.0	6.0
35°	3.7	13	31	3.7	5.5	3.5	4.9	5.3	3.7	5.6
40°	3.6	10	23	3.4	4.9	2.7	4.4	4.8	3.5	5.0
45°	3.7	8.5	17	3.2	4.7	3.1	4.2	4.5	3.4	4.8
50°	3.5	7.0	13	3.1	4.3	2.9	4.0	4.2	3.2	4.5
55°	3.3	5.9	10	2.9	4.1	2.8	3.8	4.0	3.1	4.2
60°	2.9	4.8	7.9	2.7	3.7	2.6	3.4	3.6	2.8	3.9

In Table 3 we compiled the values of brightness, contributed by the circumterrestrial cloud to the total brightness of zodiacal light for all models with $p = 4$ (for elongations 70°, 80° and 90° these values were obtained without taking account of diffraction); the brightness values are expressed in percent.

TABLE 3

$p = 4$

ε	No. of the model							ε	No. of the model						
	1–3	4	5	6	7	8	9		1–3	4	5	6	7	8	9
20′	100	2	2	8	2	13	12	30°	100	18	7	2	58	96	53
30′	100	2	2	13	3	23	22	35°	100	19	7	2	58.	95	51
40′	100	2	3	16	3	34	34	40°	100	19	7	2	56	94	48
50′	100	2	3	19	3	48	46	45°	100	19	6	3	51	93	46
1°	100	2	3	20	4	59	57	50°	100	18	7	4	49	92	47
2°	100	3	6	12	7	85	83	55°	100	16	8	4	45	91	50
3°	100	3	9	12	11	91	89	60°	100	17	9	5	44	90	51
5°	100	4	12	6	19	93	[illegible]9	70°	100	19	9	6	45	89	52
10°	100	8	14	3	41	64	80	80°	100	17	9	8	41	87	55
15°	100	11	7	2	53	96	60	90°	100	16	9	9	39	86	56

TABLE 4

$p = 3$

ε	No. of the model						ε	No. of the model					
	1–3	4	5	6	7	8		1–3	4	5	6	7	8
20′	100	7	11	6	11	12	30°	100	3	1	10	14	4
30′	100	7	14	7	16	17	35°	100	3	2	9	13	4
40′	100	7	16	7	21	22	40°	100	3	2	9	12	5
50′	100	8	18	7	27	28	45°	100	4	3	8	11	5
1°	100	8	18	8	32	33	50°	100	4	3	8	11	6
2°	100	10	12	10	45	46	55°	100	5	4	8	11	7
3°	100	11	8	12	44	43	60°	100	6	5	9	12	8
5°	100	15	2	18	28	24	70°	100	6	6	10	13	8
10°	100	6	1	6	19	10	80°	100	7	7	11	15	9
15°	100	3	1	12	22	5	90°	100	8	8	12	16	11

As may be seen from these tables, the circumterrestrial cloud contributes perceptibly to the brightness of zodiacal light (models 10, 11 and 12 cannot be considered independently).

If we apply the above-indicated criterion, estimating, for example, as nonreal a model, for which the values found for C' within the considered interval of elongations vary by more than 5 times, then for $p = 4$, all models, except 5, 6 and 9, should be rejected. For the models 6 and 9, the values of C have the same order as those found from rocket data, and for the model 5 they differ by one order. In this was, the models 5, 6 and 9 may have a real sense. Models 4, 5 and 6 assume that the circumterrestrial cloud consists of the same dust particles as the heliocentric one. It may, however, be assumed , that inside the sphere of Earth's attraction, there may exist tinier particles that would be swept out in the free interplanetary space by Sun's light pressure. In connection with this, we shall examine the models 7, 8, 9 (for $p = 4$).

Model 2 also deserves attention for $p = 4$ (circumterrestrial cloud with particles $a > 1$ mk), which gives a good brightness course along the ecliptic over the entire elongation interval except $\varepsilon < 1^o$. This model may fully explain the observed brightness course of the F-corona and of the Zodiacal light as a function of elongation, provided we assume, that there exists near the Moon a circumlunar dust cloud assuring in the immediate vicinity of the lunar limb near 90 percent of the observed brightness. As to luminescence isophots, conditioned by model 2, they may be obtained after the shape of the circumterrestrial cloud has been obtained.

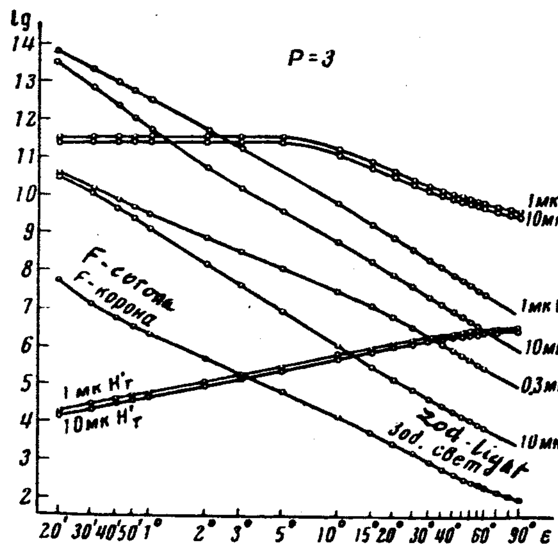


Fig. 4. - Functions H_d, H_r, H'_d and H'_r for the models with $p = 3$.

The relative contribution of the circumterrestrial dust cloud for models with the parameter $p = 3$ to the total brightness of Zodiacal light is as significant as for models with $p = 4$. This may be seen from Table 4, where the values of $B' / (B' + B)$, expressed in percent, are compiled for models with $p = 3$.

The choice of either model is not on the terms of reference of the present work plan. However, the analysis, just conducted, of various possible models shows that the circumterrestrial cloud must in any case contribute substantially to the total brightness, assuring on the ecliptic and in the cone region of the Zodiacal light at least near 10 percent of the observed brightness of the Zodiacal light. Judging from the course of brightness along the ecliptic, there is no basis for the exclusion of the possibility that the Zodiacal light is fully explained by the circumterrestrial dust cloud (model 2 with $p = 4$, and model 1 with $p = 3$). More precise conclusions on the role of the circumterrestrial dust cloud could be made only on the basis of results of especially assigned observations of Zodiacal light, for only such observations can lead to the solution of this complex question.

**** THE END ****

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